FEEDBACK CONTROLLED TENSION APPLYING SYSTEM

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to a feedback controlled tension applying system for supplying a material in continuous sheet form to a material processing device while applying tension, which is controlled to be an appropriate value, to the material.

2. DESCRIPTION OF THE RELATED ART

A conventional feedback controlled tension applying system of this type is disclosed in Japanese Patent Laid-open No. 2002-102938. This feedback tension applying system is applied to a corrugated fin processing device for manufacturing corrugated fins for automotive heat exchangers and includes a slit processing device that separates a continuously supplied fin material in sheet form into two rows, a corrugation processing device that processes the fin material separated into two rows in a longitudinal direction into corrugated form, a tension applying device that is arranged on the upstream side or down stream side of the slit processing device and applies a tension to the fin material, and a load cell that measures the tension by measuring a reaction force that acts on tension measuring rolls, which press the fin material placed between two support rolls, in order to control the tension applying device.

The tension applying device is then feedback-controlled so that a load value measured by the load cell becomes a set value that is set in advance. While applying a predetermined tension to the fin material, the fin material is controlled so that a supply length of the fin material to the slit processing device and to the corrugated fin processing device becomes a predetermined length.

However, in the above-described conventional feedback controlled tension applying system, the value of appropriate tension to be applied to the material changes in each case according to the processing accuracy of the corrugated fin processing device and the type or kind of fin material, so that, when attempting to control the supply length of the fin material to the corrugated fin processing device to be a predetermined length, a load of the load cell corresponding to the predetermined length is needed to be changed in each case. Therefore, there has been a problem in that considerable time and work are needed to or adjust the set value of the tension that is set in advance.

Further, the tension of the fin material that is applied by the tension applying device is a substitute value for a supply length amount per predetermined time, for example per unit time, of the fin material to be supplied to the corrugated fin processing device (corresponding to the supply speed of the fin material). When the tension applying device is feedback-controlled based on a measurement result, not a moving length amount per predetermined time but a load, of the load cell, there has been a problem in that, if dispersion in height, length, louver angle or the like of a processed corrugated fin occurs, it is difficult to identify a cause of the dispersion.

Furthermore, since the tension applying device uses frictional forces of felt pads that sandwich the fin material as a method for applying tension to the fin material, there has been a possibility of product variation caused by a change of coefficient of dynamic friction of the fin material, a rapid increase of load to the fin material when the corrugated fin processing device transits from a halt state to an operating state, or the like.

The present invention is made in view of the above described problems, and an object thereof is to provide a feedback controlled tension applying system that is capable of easily changing a control setting to make the length per unit time of the material supplied to the material processing device become a

predetermined value when the processing accuracy of the material processing device or the type or kind of a fin material are changed when supplying a material in continuous sheet form to the material processing device while applying a tension to the material, and is capable of improving the precision of products processed by the material processing device.

SUMMARY OF THE INVENTION

In order to achieve the object stated above, a feedback controlled tension applying system according to the present invention comprises a material processing device that processes a material in continuous sheet form while applying a tension to the material, a tension applying device that applies the tension to the material, a measuring means for measuring a moving length amount per predetermined time of the material and a control device that feedback-controls the tension applying device based on a measurement result of the measuring means so that the moving length amount per predetermined time of the material becomes a set value that is set in advance.

Therefore, in the feedback controlled tension applying system according to this embodiment, the tension applying device is feedback-controlled based on the measurement result of the measuring means, which measures the moving length amount per predetermined time of the material, so that the moving length amount per predetermined time of the material becomes the set value that is set in advance. Thus, as compared to the case similar to the above-described conventional art in which the tension load of the material is measured for controlling the moving length amount per predetermined time of the material, the control of moving length amount per predetermined time of the material can be easily changed in order to supply the material having a predetermined length amount per predetermined time to the material processing device when the processing accuracy of the material processing device or the type or kind of the fin material changes. As a result, the supply length amount per predetermined time of the material can be

controlled to improve product precision of the material processing device.

Preferably, the measuring means comprises a measuring roll that rotates in contact with the material and an encoder that detects an amount regarding a rotation angle of the measuring roll. The measuring means measures the moving length amount per predetermined time of the material based on the amount regarding the rotation angle of the measuring roll detected by the encoder.

Therefore, in this feedback controlled tension applying system, it becomes possible to measure the moving length amount per predetermined time of the material by using the measuring roll and the encoder, so that the control of moving (supply) length amount per predetermined time of the material to the material processing device can be easily changed, and the product precision of the processing device can be improved.

Preferably, in the feedback controlled tension applying system, the tension applying device comprises a base, an arm having one and other end portions thereof, the one end portion of the arm being fixed to the base so as to be swingable in upward and downward directions and the other end portion of the arm being provided with a pulley that applies a load on the material, and a balance weight that moves on the arm in opposite directions along the arm by control of the control device.

Therefore, in this feedback controlled tension applying system, the tension applying means has the arm whose one end portion is fixed to the base so as to be swingable in the upward and downward directions and the other end portion provided with the pulley that applies a load on the material. The balance weight moves on the arm by control of the control device, so that an adjusted tension can be applied on the material through the pulley by moving the balance weight on the arm, and thus the tension on the material can be easily set in a very small unit and finely adjusted.

Further, since the tension is applied on the material through the pulley, it is not necessary, as compared to tension applied by the frictional force of a pad, to consider the change of coefficient of dynamic friction that is different on each material, the abrasion of the pad, and the like.

Preferably, in the feedback controlled tension applying system, the processing device performs processing in a longitudinal direction of the material.

Therefore, in this feedback controlled tension applying system, since the processing device performs processing in the longitudinal direction of the material, it is possible to control a supply amount per predetermined time of the material in the longitudinal direction thereof, which is most important when the material processing device processes a material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing a feedback controlled tension applying system according to an embodiment of the present invention; and

FIG. 2 is a view describing operation of the feedback controlled tension applying system according to the embodiment when a moving length amount per predetermined time of a fin material per unit time exceeds a set value.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a feedback controlled tension applying system according to an embodiment of the present invention will be described with reference to the attached drawings.

The feedback controlled tension applying system according to this embodiment is here applied to a corrugated fin processing device for manufacturing corrugated fins of automotive heat exchangers such as condensers and radiators.

FIG. 1 is a schematic view of a feedback controlled tension applying system 100 according to the embodiment of the present invention, and FIG. 2 is a view describing operation of the feedback controlled tension applying system 100 according to this embodiment.

As shown in FIG. 1, the feedback controlled tension applying system 100 according to the embodiment of the present invention has a corrugated fin processing device 2 that processes a continuously supplied fin material 1 in sheet form, a pair of free dump rolls 3 that supply the fin material 1 to the downstream side of the feedback controlled tension applying system 100, a tension applying device 4 that applies a tension to the fin material 1, and a control system 25 that controls the tension applying device 4.

The corrugated fin processing device 2 is constituted of a slit processing device 2a that separates the fin material 1 in two rows along a moving direction of the fin material 1 with a pair of cutters 7, and a corrugation processing device 2b that corrugates the fin material 1, which is separated in two, by a pair of corrugate cutters 8. The corrugated fin processing device 2 functions as a material processing unit of the present invention.

The control system 25 includes a measuring unit 22 that detects a moving length amount per predetermined time of the fin material 1, a control device 10 that receives an input of a signal regarding the moving length amount per predetermined time of the fin material 1 measured by the measuring means 22 and outputs a control signal, and an electropneumatic regulator 4g that adjusts an air supply amount based on the control signal outputted from the control device 10.

The measuring unit 22 includes a pair of measuring rolls 5 that sandwiches the fin material 1 and rotates in association with movement of the fin material 1, and an encoder 6 that detects a rotation angle of the measuring rolls 5 and outputs a signal regarding the moving length per unit time of the fin material 1 based on the rotation angle of the measuring roll 5 detected by the encoder 6. The control device 10 has a sequencer unit 11 that receives an input of the signal regarding the moving length amount per predetermined time of the fin material 1 detected by the encoder 6 and outputs a digital control signal obtained by comparing the signal regarding the moving length amount per predetermined time of the fin material 1 with a set value that is set in advance and calculating the moving length amount per predetermined time of the fin material 1 to match the set value, and a D/A converter 13 that converts the digital control signal outputted from the sequencer unit 11 into an analog control signal and outputs the analog control signal to the electropneumatic regulator 4g.

The electropneumatic regulator 4g supplies an air supply amount to an air cylinder 4f of the tension applying device 4 according to the analog control signal inputted from the control device 10.

Next, the tension applying device 4 will be described.

The tension applying device 4 has a base 4a that is placed on the floor, not shown, and extends in a direction perpendicular to the floor, and an arm 4c whose one end portion is swingably fixed on a pivot 4b provided on the top end of the base 4a.

On the other end portion of the arm 4c, a pulley 4d is rotatably provided. On a portion of the arm 4c in the vicinity of the pulley 4d, a balance weight 4e is provided to be movable along and lockable on the arm 4c.

The balance weight 4e is coupled to the piston rod of a piston, not shown, movable in the air cylinder 4f, and moves in opposite directions on the arm 4c following extension and contraction of the piston rod relative to the air cylinder 4f, controlled by the control device 10, and thereafter locks at a desirable position.

Incidentally, a flow amount of air for driving the piston supplied to the air cylinder 4f is controlled by the electropneumatic regulator 4g.

Further, a fixed balance weight 4h for balancing the arm 4c is attached on the one side portion of the arm 4c.

Hereinafter, operation of the feedback controlled tension applying system 100 according to the present invention will be described.

In the feedback controlled tension applying system 100 according to this embodiment, the fin material 1 supplied from the free dump rolls 3 to the downstream side thereof is guided through a fixed pulley 20 to the pulley 4d of the tension applying device 4, and then the fin material 1 is guided in a state such that a downward load is applied thereon through a fixed pulley 21 to the measuring rolls 5.

Furthermore, the fin material 1 is guided through the measuring rolls 5 to the slit processing device 2a and the corrugation processing device 2b, and appropriate processes are performed therethrough, such as separating the fin material 1 in to two rows along its longitudinal direction, corrugating the fin material 1, and the like to thereby form a corrugated fin 1a.

Incidentally, while moving and processing the above-described fin material 1, in the control device 10, the sequencer unit 11 takes in the result of measuring the rotation angle of the measuring rolls 5 measured by the encoder 6.

In the sequencer unit 11, the moving length amount per predetermined time of the fin material 1 is calculated based on the measurement result of the encoder 6, the moving length amount per predetermined time of the fin material 1 is compared with a set value that is set in advance, and a digital control signal, obtained by calculating the moving length amount per predetermined time of the fin material 1 to match the set value, is converted by the D/A converter 13 into an analog control signal so as to control the electropneumatic regulator 4g, thereby adjusting the air flow amount to be supplied to the air cylinder 4f.

The electropneumatic regulator 4g adjusts the air flow amount in the air cylinder 4f to extend or contract the piston rod relative to air cylinder 4f according to the analog control signal. As a result, the balance weight 4e appropriately moves in right and left directions on the arm 4c, thereby applying a predetermined tension to the fin material 1 through the pulley 4d of the arm 4c.

For example, as shown in FIG. 2, when the moving length amount per predetermined time of the fin material 1 exceeds the set value, the air flow amount of the air cylinder 4f is increased so as to extend the piston rod of the air cylinder 4f toward the right side in the figure, and thereby the balance weight 4e is moved on the arm 4c in a direction of arrow 31 so as to rotate the end portion on the other side of the arm 4c in the downward direction, so that a larger force in the downward direction acts on the fin material 1 between the fixed pulley 20 and the fixed pulley 21.

As a result, the pulley 4d increases the tension in a longitudinal direction, namely, the moving direction of the fin material 1, so that the moving length amount per predetermined time of the fin material 1 to the downstream side is restrained in a direction to be small. Further, when the moving length amount per predetermined time of the fin material 1 is equal to or less than

the set value, the balance weight 4e is moved so as to decrease the tension contrary to the above-mentioned case, thereby increasing the moving length amount per predetermined time of the fin material 1.

Incidentally, the free dump rolls 3 are controlled in such a manner that the supply length amount per predetermined time of the fin material 1 to the pulley 4d is appropriately controlled by a control device, not shown, to provide an appropriate moving range of the pulley 4d of the tension applying device 4.

Then, the control device 10 feedback-controls the tension applying device 4 based on the measurement result of the encoder 6 so that the moving length amount per predetermined time of the fin material 1 always becomes the set value that is set in advance, and adjusts the tension on the fin material 1 in real time.

Therefore, in the feedback controlled tension applying system 100 according to this embodiment, the moving length amount per predetermined time of the fin material 1 is measured by the encoder 6 and the tension on the fin material 1 is adjusted while feedback-controlling the tension applying device 4 based on the measurement result thereof, so that, when processing accuracy of the corrugate cutters 8 or the type or kind of the fin material 1 is changed, the moving length amount per predetermined time of the fin material 1 can be easily changed to supply a predetermined length amount per predetermined time of the fin material 1 to the corrugated fin processing device 2, thereby realizing formation of the corrugated fin 1a with high product precision.

Further, as compared to the conventional art, it is not necessary to consider the change of coefficient of dynamic friction or the like that is different on each fin material, so that the set value of the moving amount of the fin material 1 can be easily set or adjusted, and also the cause of an obstruction

can be easily identified when it occurs.

The feedback controlled tension applying system according to the embodiment of the present invention has been described above, but the specific structure of the present invention is not limited to the above-described embodiment. The present invention includes any change in design without departing from the gist of the invention.

For example, in this embodiment, the example of the feedback controlled tension applying system 100 applied to the corrugated fin processing device 2 for heat exchangers has been described, but the invention is not limited to this, and it is needless to mention that the invention can be applied to, for example, a general roll forming device.

The entire contents of Japanese Patent Application Tokugan 2003-013917 (filed Jan. 22, 2003) are incorporated herein by reference.